http://www.350.org October 2009

350 ppm

What does 350 mean?

350 ppm is the number that leading scientists say is the safe upper limit for carbon dioxide. It's the number humanity needs to get back to as soon as possible to avoid runaway climate change.

We're already well past 350*, are we all doomed?

No. We're like the patient that goes to the doctor and learns he's overweight, or his cholesterol is too high. He doesn't die immediately—but until he changes his lifestyle and gets back down to the safe zone, he's at more risk for heart attack or stroke. The planet is in its danger zone because we've poured too much carbon into the atmosphere, and we're starting to see signs of real trouble: melting ice caps, rapidly spreading drought. We need to scramble back as quickly as we can to safety.

*387 ppm in October 2010

350 ppm

How do we actually reduce carbon emissions to get to 350?

Make no mistake—getting back to 350 means transforming our world. It means building solar arrays instead of coal plants, it means planting trees instead of clear-cutting rainforests, it means increasing efficiency and decreasing our waste.

Getting to 350 means developing a thousand different solutions—all of which will become much easier if we have a global treaty grounded in the latest science and built around the principles of equity and justice. To get this kind of treaty, we need a movement of people who care enough about our shared global future to get involved and make their voices heard.

Why 350 ppm?

Where did this 350 number come from?
Dr. James Hansen, of NASA, has been researching global warming longer than just about anyone else. He was the first to publicly testify before the U.S. Congress, in June of 1988, that global warming was real. He and his colleagues have used both real-world observation, computer simulation, and mountains of data about ancient climates to calculate what constitutes dangerous quantities of carbon in the atmosphere.

The Bush Administration tried to keep Hansen and his team from speaking publicly, but their analysis has been widely praised by other scientists. The full text of James Hansen's paper about 350 - H*ansen et al., Open Atmos. Sci. J. (2008), vol. 2, pp. 217-231* - can be found at: http://arxiv.org/abs/0804.1126

Open Access

Target Atmospheric CO_2: Where Should Humanity Aim?

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Abstract: Paleoclimate data show that climate sensitivity is ~3°C for doubled CO_2, including only fast feedback processes**.** Equilibrium sensitivity, including slower surface albedo feedbacks, is ~6°C for doubled CO_2 for the range of climate states between glacial conditions and ice-free Antarctica. Decreasing CO_2 was the main cause of a cooling trend that began 50 million years ago, the planet being nearly ice-free until CO_2 fell to 450 ± 100 ppm; barring prompt policy changes, that critical level will be passed, in the opposite direction, within decades. **If humanity wishes to preserve a planet similar to that on which civilization developed and to which life on Earth is adapted, paleoclimate evidence and ongoing climate change suggest that CO_2 will need to be reduced from its current 385 ppm to at most 350 ppm, but likely less than that.** The largest uncertainty in the target arises from possible changes of non-CO_2 forcings. **An initial 350 ppm CO_2 target may be achievable by phasing out coal use except where CO_2 is captured and adopting agricultural and forestry practices that sequester carbon.** If the present overshoot of this target CO_2 is not brief, there is a possibility of seeding irreversible catastrophic effects.

Fast versus slow feedbacks

Fast feedbacks (weeks/years)	Slow feedbacks (decades/centuries)
H_2O vapour increase (T)	Land ice melting
Sea-ice melting	Forest cover change
Clouds	Sea-level rise
Dust	Methane release from permafrost
CO_2 partitioning (water/air)	Methane release from m-hydrates

Most existing models and forecasts and most studies of current climate response to increased GHG levels only consider fast feedbacks. The estimated forcing from the fast-feedback mechanisms is 0.75 °C* per W/m^2.

According to Hansen et al., the estimated forcing from the combined fast and slow feedbacks is 1.5 °C per W/m^2 .

*global average T

Well-understood impacts of reaching equilibrium with today's CO_2 level of 385 ppm:

•Increased aridity in southern US, Mediterranean, Australia and parts of Africa

•Loss of alpine glaciers in the Himalayas, Alps, Andes and Rockies leading to serious summer-time water shortages for hundreds of millions of people

•Sea-level rise of at least several metres

Hansen et al., 2008

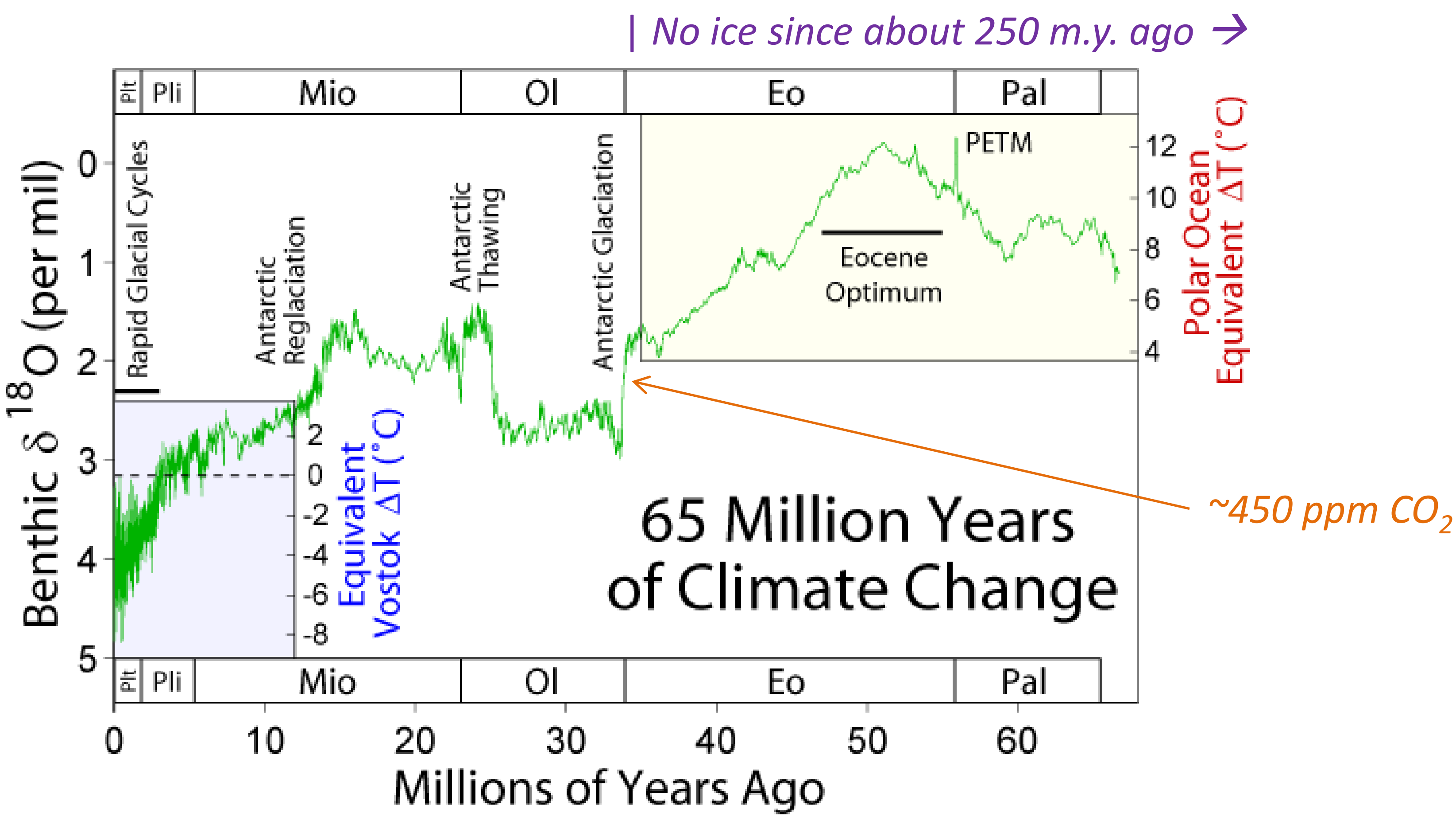
Tipping Points

"We define: (1) the *tipping level, the global climate forcing* that, if long maintained, gives rise to a specific consequence, and (2) the *point of no return, a climate state beyond* which the consequence is inevitable, even if climate forcings are reduced. A point of no return can be avoided, even if the tipping level is temporarily exceeded. Ocean and ice sheet inertia permit overshoot, provided the climate forcing is returned below the tipping level before initiating irreversible dynamic change."

"Arctic sea ice and the West Antarctic Ice Sheet are examples of potential tipping points. Arctic sea ice loss is magnified by the positive feedback of increased absorption of sunlight as global warming initiates sea ice retreat. West Antarctic ice loss can be accelerated by several feedbacks, once ice loss is substantial."

Hansen et al., 2008

“Our estimated history of CO_2 through the Cenozoic Era provides a sobering perspective for assessing an appropriate target for future CO_2 levels. A CO_2 amount of order 450 ppm or larger, if long maintained, would push Earth toward the ice-free state. Although ocean and ice sheet inertia limit the rate of climate change, such a CO_2 level likely would cause the passing of climate tipping points and initiate dynamic responses that could be out of humanity’s control. “



Proposals for getting to 350 ppm

1) Phase out emissions from coal by 2030 *(either stop using coal altogether, or ensure CO_2 sequestration at coal plants)*

2) Reforestation of a significant part of the land that has been deforested over the past 2 centuries *(means converting some crop land back into forest)*

3) Carbon sequestration in soil using bio-char methods

Hansen et al., 2008

Climate engineering (this text is from New Scientist)

Many scenarios have been proposed to help us engineer our way out of potential climate disaster, and now a new study could point us towards the ones that are most effective.

Tim Lenton of the University of East Anglia, UK, has put together the first comparative assessment of climate-altering proposals such pumping sulphur into the atmosphere to mimic the cooling effect of volcanic emissions, or fertilising the oceans with iron.

"There is a worrying feeling that we're not going to get our act together fast enough," says Lenton, referring to international efforts to limit greenhouse gas emissions. Scientists have reached a "social tipping point" and are starting to wonder which techniques might complement emissions cuts, he says.
Lenton says he is not necessarily advocating engineering the climate, but, faced with a growing trend among his peers, he and colleague Naomi Vaughan decided to provide a comparison of the options that are on the table.

First, Lenton says the exercise shows there is no "silver bullet" – no single method that will safely reverse climate change on its own.

New Scientist, January 2009 - http://www.newscientist.com/article/dn16495-most-effective-climate-engineering-solutions-revealed.html

Scrubbers and mirrors

Climate engineering schemes would work by either removing carbon dioxide from the atmosphere, or reflecting solar energy back out into space – both with the intention of lowering global temperatures.

Proposals for removing CO_2 from the atmosphere include planting vast forests, chemically absorbing the gas, or turning agricultural waste into charcoal (bio-char) and burying it.

Reflecting solar energy back into space does not decrease the levels of greenhouse gases in the atmosphere, but lessens their warming effect by reducing the amount of solar energy that gets trapped near Earth's surface. Possible schemes have included space mirrors in orbit around the planet, clouds of sulphur particles in the atmosphere, or ground-based reflectors. The researchers calculated how effective each scheme is at reducing the amount of solar energy trapped in our climatic system – a measure known as "radiative forcing".

New Scientist, January 2009

Sunshade risks

If we continue to burn fossil fuels at the same rate as today, the greenhouse effect will boost radiative forcing by 7 watts per square metre of Earth surface by 2100. By some calculations, strict targets to reduce emissions could bring that down by 4 W/m^2.

Lenton's calculations show the only methods powerful enough to have a significant effect in the relatively short term (in the second half of this century) involve placing physical barriers between Earth and the Sun. This would involve either orbiting space mirrors, stratospheric mists of sulphur, or using seawater to make reflective clouds.

But Lenton warns that these options also carry the most risk. A sulphur sunshade could reduce radiative forcing by 3.7 W/m^2, but would have to be continually replenished. If it was allowed to disappear, temperatures could shoot up by as much as 5 °C within decades (*Climatic Change*, DOI: 10.1007/s10584-008-9490-1).

After sunshades, the most effective method is "scrubbing" carbon dioxide out of air and storing it underground. This could reduce radiative forcing by 1.9 W/m^2 by 2100.

New Scientist, January 2009

Burn it and bury it

Most other methods, including increasing the reflectivity of deserts or fields of crops, and fertilising oceans show little promise or would not have global effects, the study shows. Some, like increasing the reflectivity of roofs in cities, could offer localised relief from climate change.

"There's been far too much focus on iron fertilisation" given its lack of potential, says Lenton. His calculations suggest that the boost which agricultural fertilisers inadvertently give ocean plankton in runoff is probably already more effective that iron seeding is ever likely to be.

Lenton says turning agricultural waste into charcoal and burying it may hold the most promise. Although it would only reduce radiative forcing by 0.4 W/m^2 by 2100, the method is cheap, low tech, and would have the added advantage of fertilising the soil.

Journal reference: *Atmospheric Chemistry and Physics* (9, 1-50, 2009)

New Scientist, January 2009